US 20150237366A1

(19) United States

(12) Patent Application Publication

CHO et al.

(10) Pub. No.: US 2015/0237366 A1

(43) Pub. Date: Aug. 20, 2015

(54) MOVING PICTURE ENCODING/DECODING APPARATUS AND METHOD FOR PROCESSING OF MOVING PICTURE DIVIDED IN UNITS OF SLICES

(71) Applicants: **SAMSUNG ELECTRONICS CO., LTD.**, Gyeonggi-do (KR); **KWANGWOON UNIVERSITY INDUSTRY-ACADEMIC COLLABORATION FOUNDATION**, Seoul (KR)

(72) Inventors: **Dae-sung CHO**, Seoul (KR); **Woong-Il CHOI**, Hwaseong-si (KR); **Kwan-woong SONG**, Seongnam-si (KR); **Young-hun JOO**, Yongin-si (KR); **Yong-Serk KIM**, Seoul (KR); **Dong-Gyu SIM**, Seoul (KR); **Jung-Hak NAM**, Seoul (KR); **Bong-Il JI**, Seoul (KR)

(73) Assignees: **SAMSUNG ELECTRONICS CO., LTD.**, Gyeonggi-do (KR); **KWANGWOON UNIVERSITY INDUSTRY-ACADEMIC COLLABORATION FOUNDATION**, Seoul (KR)

(21) Appl. No.: **14/700,863**

(22) Filed: **Apr. 30, 2015**

Related U.S. Application Data

(63) Continuation of application No. 13/128,723, filed on May 11, 2011, now Pat. No. 9,042,456, filed as application No. PCT/KR2009/006484 on Nov. 5, 2009.

(30) **Foreign Application Priority Data**

Nov. 11, 2008 (KR) 10-2008-0111850

Publication Classification

(51) **Int. Cl.**

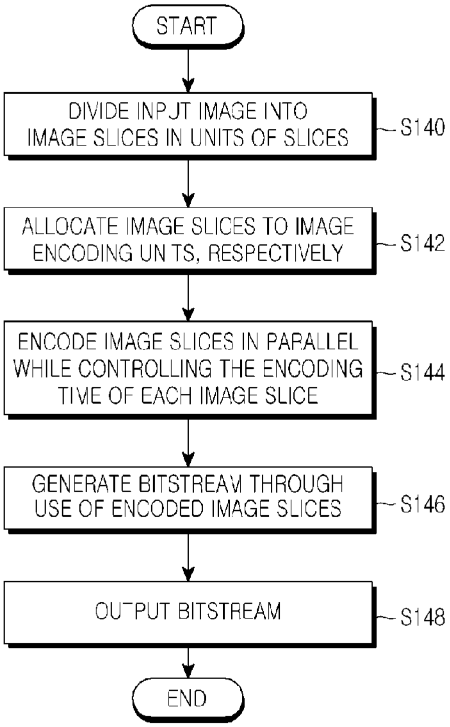
H04N 19/513 (2006.01)
H04N 19/436 (2006.01)

(52) **U.S. Cl.**

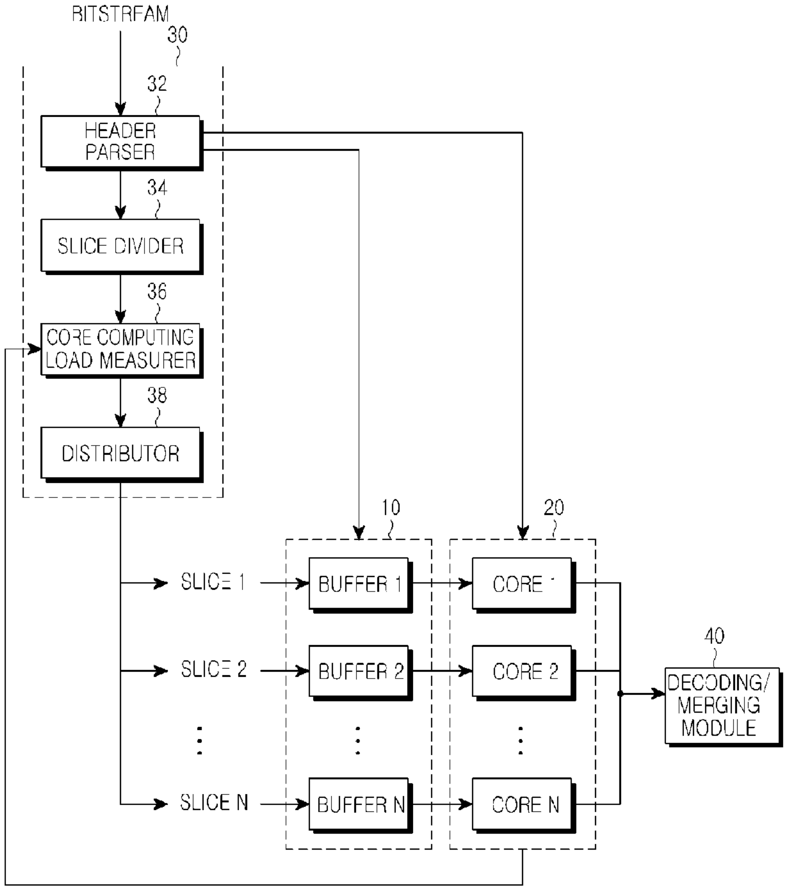
CPC ***H04N 19/513*** (2014.11); ***H04N 19/436*** (2014.11)

(57) ABSTRACT

Disclosed is a moving picture encoding/decoding apparatus and method for processing of a moving picture, which is divided in units of slices. The encoding method includes the steps of: dividing a moving picture in units of slices when the moving picture is received; determining an encoding order of moving pictures divided in units of slices; and generating a bitstream by encoding moving pictures, which are divided in unites of slices, according to a corresponding order when the encoding order has been determined.


START
DIVIDE INPJT IMAGE INTO IMAGE SLICES IN UNITS OF SLICES
S140
ALLOCATE IMAGE SLICES TO IMAGE ENCODING UNITS, RESPECTIVELY
S142
ENCODE IMAGE SLICES IN PARALLEL WHILE CONTROLLING THE ENCODING TIME OF EACH IMAGE SLICE
S144
GENERATE BITSTREAM THROUGH USE OF ENCODED IMAGE SLICES
S146
OUTPUT BITSTREAM
S148
END

[Fig. 1]


BITSTREAM
30
32
HEADER PARSER
34
SLICE DIVIDER
36
CORE COMPUTING LOAD MEASURER
38
DISTRIBUTOR
10
20
SLICE 1
BUFFER 1
CORE 1
SLICE 2
BUFFER 2
CORE 2
SLICE N
BUFFER N
CORE N
40
DECODING/ MERGING MODULE

[Fig. 2]

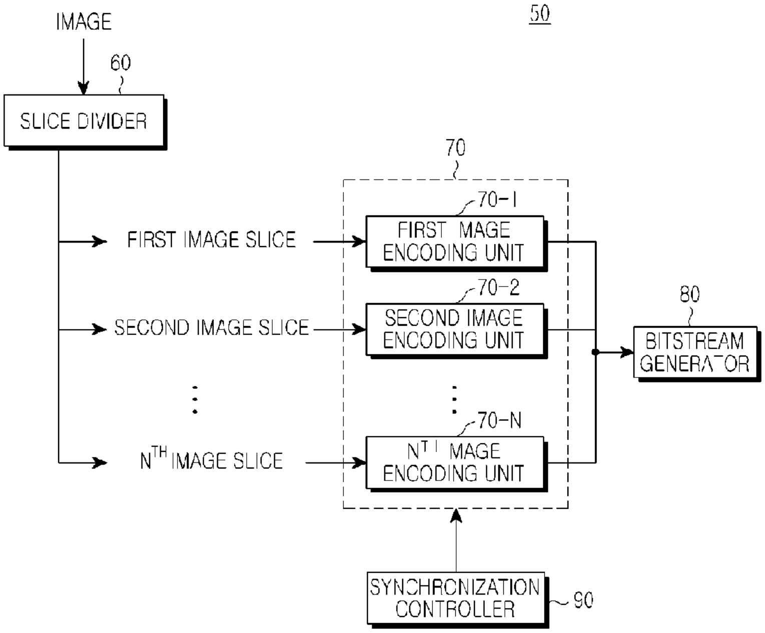
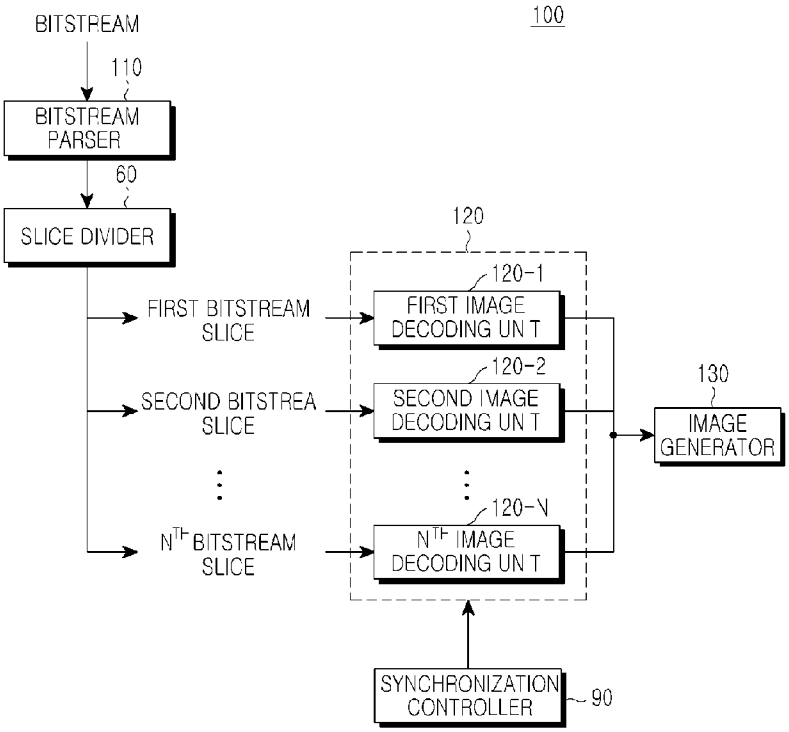
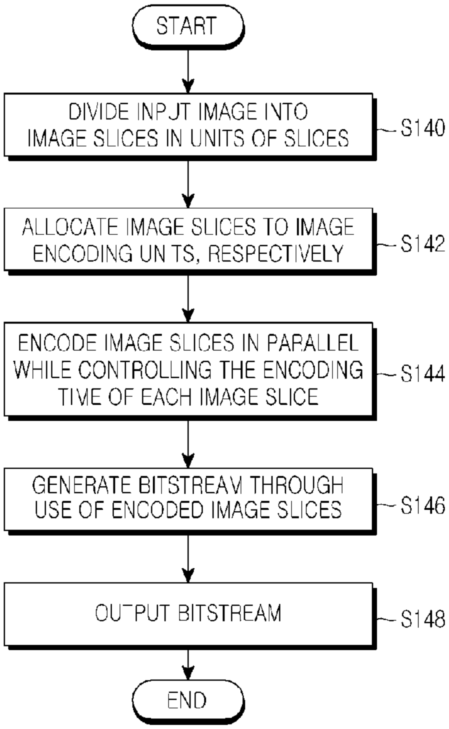


IMAGE
60
SLICE DIVIDER
50
70
70-1
FIRST IMAGE SLICE
FIRST IMAGE ENCODING UNIT
70-2
SECOND IMAGE SLICE
SECOND IMAGE ENCODING UNIT
70-N
N^TH IMAGE SLICE
N^TH IMAGE ENCODING UNIT
80
BITSTREAM GENERATOR
SYNCHRONIZATION CONTROLLER
90

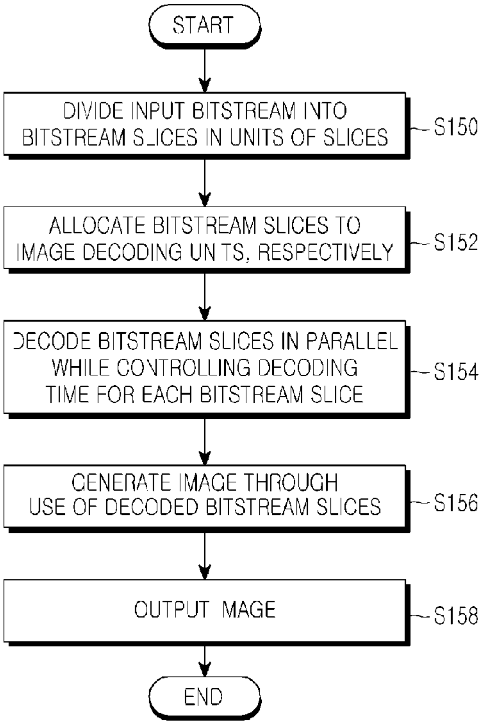
[Fig. 3]


100
BITSTREAM
110
BITSTREAM PARSER
60
SLICE DIVIDER
120
120-1
FIRST BITSTREAM SLICE
FIRST IMAGE DECODING UN T
120-2
SECOND BITSTREA SLICE
SECOND IMAGE DECODING UN T
130
IMAGE GENERATOR
120-N
NTH BITSTREAM SLICE
NTH IMAGE DECODING UN T
SYNCHRONIZATION CONTROLLER
90

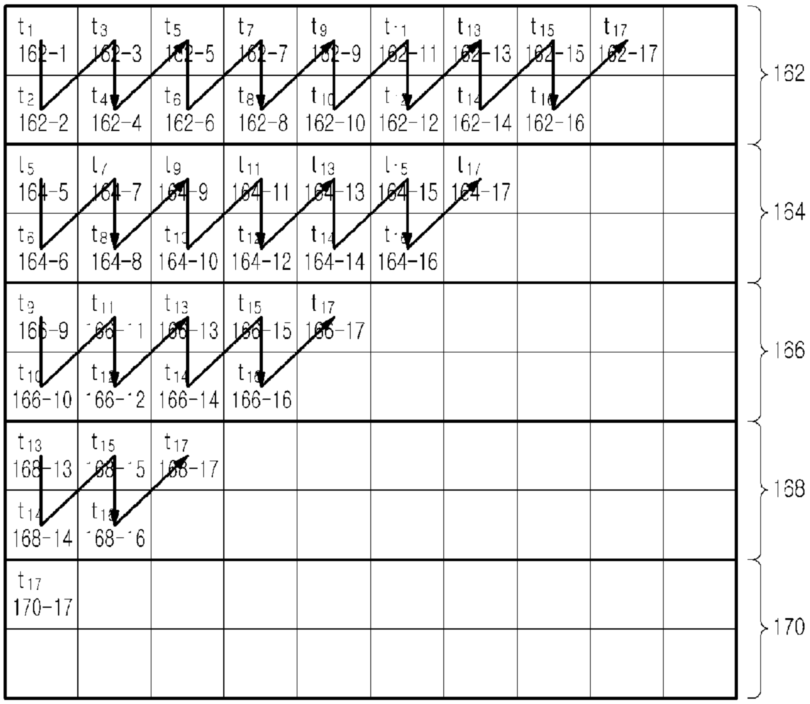
[Fig. 4]


START
DIVIDE INPJT IMAGE INTO IMAGE SLICES IN UNITS OF SLICES
S140
ALLOCATE IMAGE SLICES TO IMAGE ENCODING UN TS, RESPECTIVELY
S142
ENCODE IMAGE SLICES IN PARALLEL WHILE CONTROLLING THE ENCODING TIME OF EACH IMAGE SLICE
S144
GENERATE BITSTREAM THROUGH USE OF ENCODED IMAGE SLICES
S146
OUTPUT BITSTREAM
S148
END

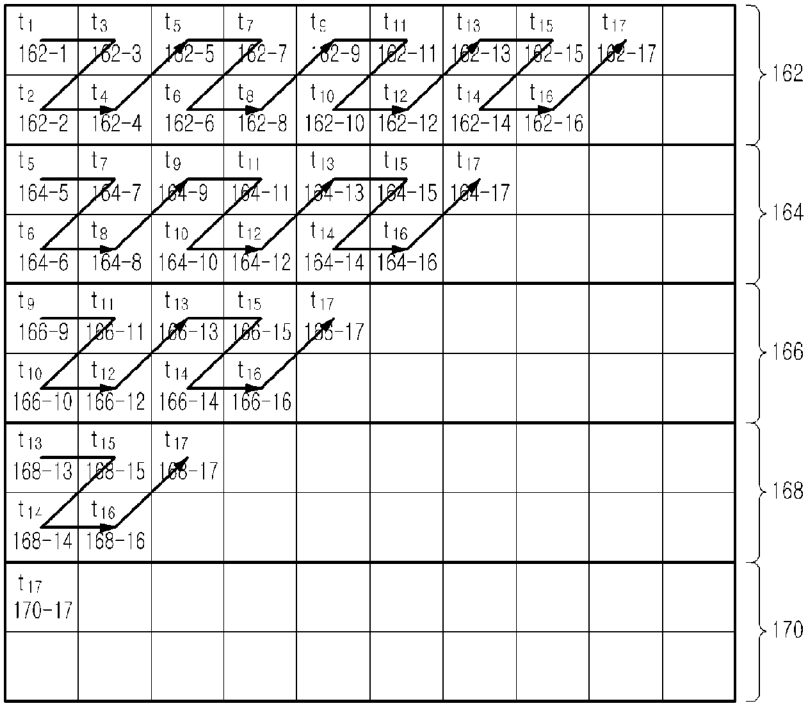
[Fig. 5]


START
DIVIDE INPUT BITSTREAM INTO BITSTREAM SLICES IN UNITS OF SLICES
S150
ALLOCATE BITSTREAM SLICES TO IMAGE DECODING UNITS, RESPECTIVELY
S152
DECODE BITSTREAM SLICES IN PARALLEL WHILE CONTROLLING DECODING TIME FOR EACH BITSTREAM SLICE
S154
GENERATE IMAGE THROUGH USE OF DECODED BITSTREAM SLICES
S156
OUTPUT IMAGE
S158
END

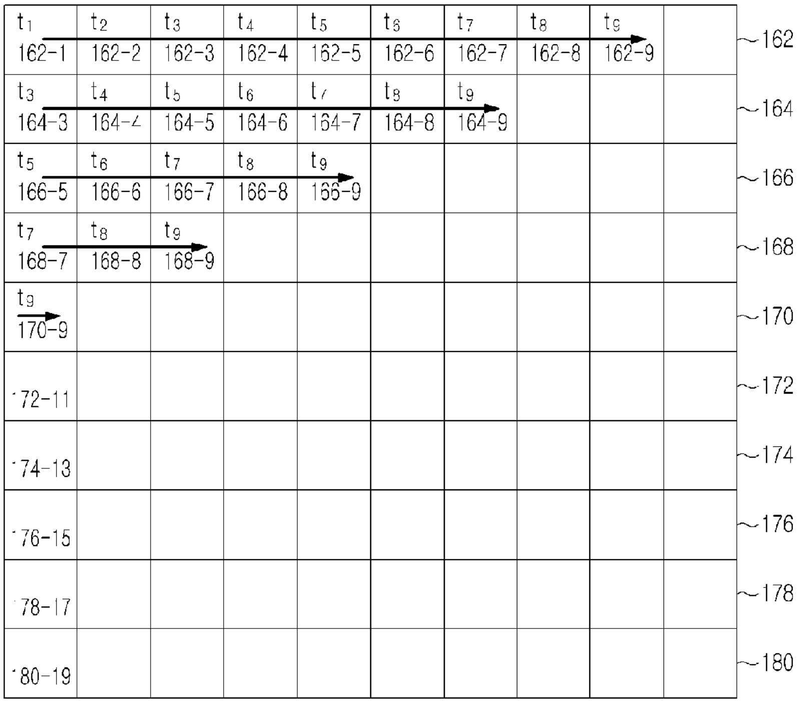
[Fig. 6]


t1 162-1
t3 162-3
t5 162-5
t7 162-7
t9 162-9
t11 162-11
t13 162-13
t15 162-15
t17 162-17
t2 162-2
t4 162-4
t6 162-6
t8 162-8
t10 162-10
t12 162-12
t14 162-14
t16 162-16
162
t5 164-5
t7 164-7
t9 164-9
t11 164-11
t13 164-13
t15 164-15
t17 164-17
t6 164-6
t8 164-8
t10 164-10
t12 164-12
t14 164-14
t16 164-16
164
t9 166-9
t11 166-11
t13 166-13
t15 166-15
t17 166-17
t10 166-10
t12 166-12
t14 166-14
t16 166-16
166
t13 168-13
t15 168-15
t17 168-17
t14 168-14
t16 168-16
168
t17 170-17
170

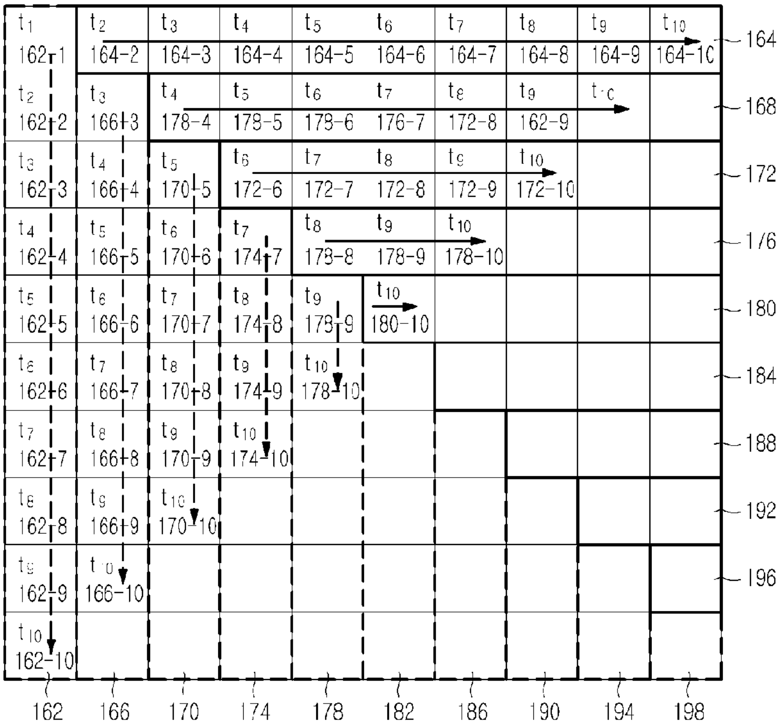
[Fig. 7]


t1 162-1
t3 162-3
t5 162-5
t7 162-7
t9 162-9
t11 162-11
t13 162-13
t15 162-15
t17 162-17
t2 162-2
t4 162-4
t6 162-6
t8 162-8
t10 162-10
t12 162-12
t14 162-14
t16 162-16
162
t5 164-5
t7 164-7
t9 164-9
t11 164-11
t13 164-13
t15 164-15
t17 164-17
t6 164-6
t8 164-8
t10 164-10
t12 164-12
t14 164-14
t16 164-16
164
t9 166-9
t11 166-11
t13 166-13
t15 166-15
t17 166-17
t10 166-10
t12 166-12
t14 166-14
t16 166-16
166
t13 168-13
t15 168-15
t17 168-17
t14 168-14
t16 168-16
168
t17 170-17
170

[Fig. 8]

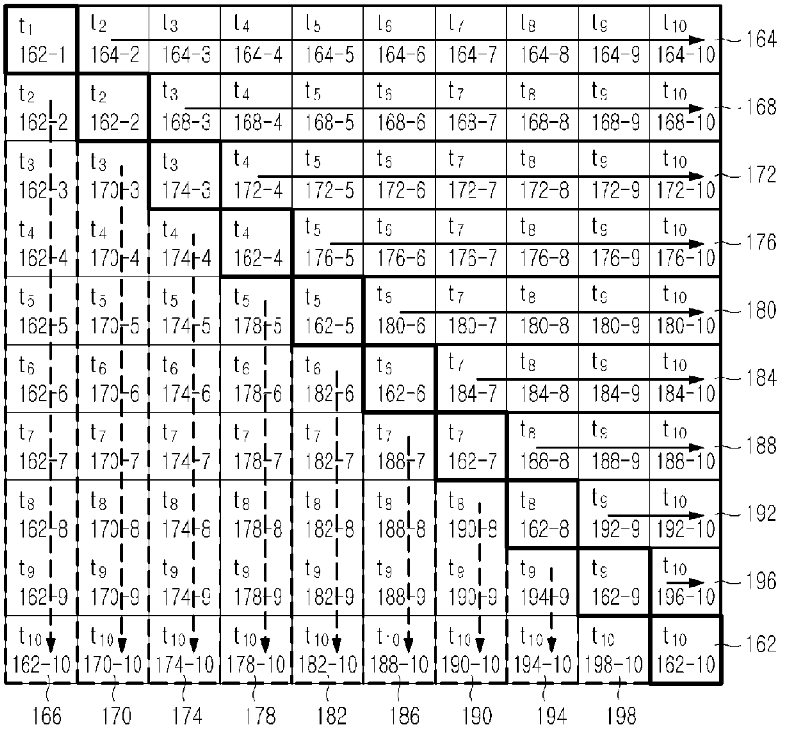

t1 162-1
t2 162-2
t3 162-3
t4 162-4
t5 162-5
t6 162-6
t7 162-7
t8 162-8
t9 162-9
162
t3 164-3
t4 164-4
t5 164-5
t6 164-6
t7 164-7
t8 164-8
t9 164-9
164
t5 166-5
t6 166-6
t7 166-7
t8 166-8
t9 166-9
166
t7 168-7
t8 168-8
t9 168-9
168
t9 170-9
170
72-11
172
74-13
174
76-15
176
78-17
178
80-19
180

[Fig. 9]



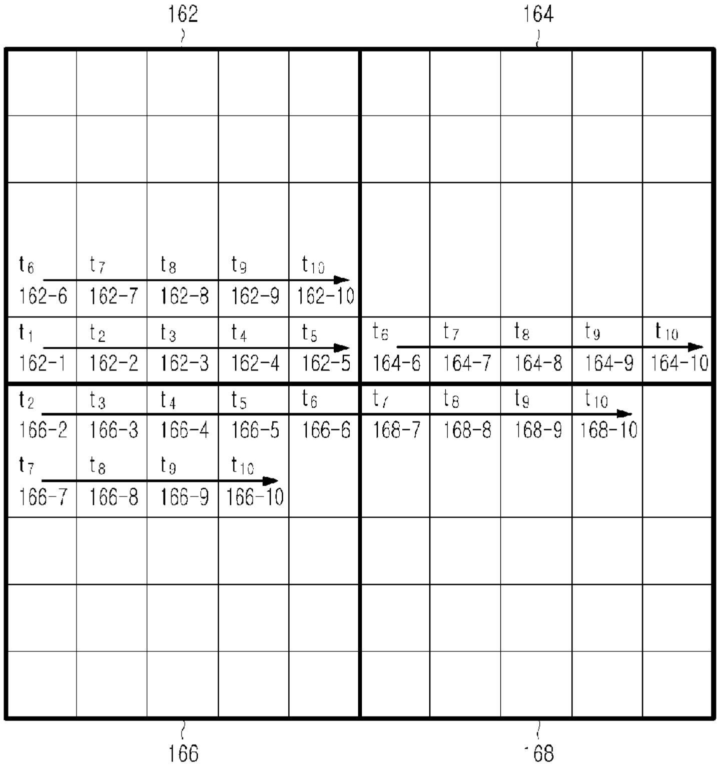
t_1 162-1	t_2 164-2	t_3 164-3	t_4 164-4	t_5 164-5	t_6 164-6	t_7 164-7	t_8 164-8	t_9 164-9	t_{10} 164-1C
t_2 162-2	t_3 166-3	t_4 178-4	t_5 178-5	t_6 178-6	t_7 176-7	t_8 172-8	t_9 162-9	t·c	
t_3 162-3	t_4 166-4	t_5 170-5	t_6 172-6	t_7 172-7	t_8 172-8	t_9 172-9	t_{10} 172-10		
t_4 162-4	t_5 166-5	t_6 170-6	t_7 174-7	t_8 178-8	t_9 178-9	t_{10} 178-10			
t_5 162-5	t_6 166-6	t_7 170-7	t_8 174-8	t_9 178-9	t_{10} 180-10				
t_6 162-6	t_7 166-7	t_8 170-8	t_9 174-9	t_{10} 178-10					
t_7 162-7	t_8 166-8	t_9 170-9	t_{10} 174-10						
t_8 162-8	t_9 166-9	t_{10} 170-10							
t_9 162-9	t·0 166-10								
t_{10} 162-10									

[Fig. 10]

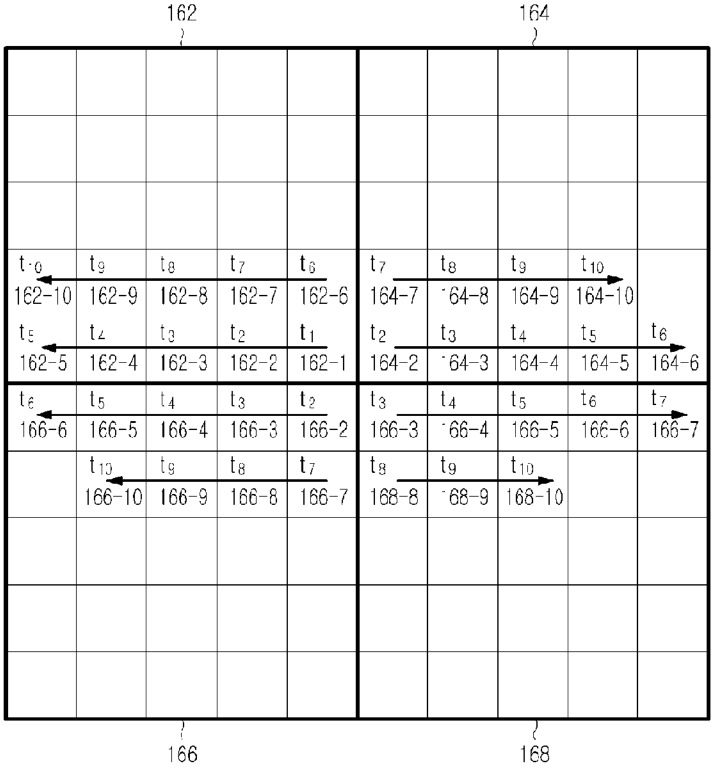


t_1 162-1	t_2 164-2	t_3 164-3	t_4 164-4	t_5 164-5	t_6 164-6	t_7 164-7	t_8 164-8	t_9 164-9	t_{10} 164-10
t_2 162-2	t_2 162-2	t_3 168-3	t_4 168-4	t_5 168-5	t_6 168-6	t_7 168-7	t_8 168-8	t_9 168-9	t_{10} 168-10
t_3 162-3	t_3 170-3	t_3 174-3	t_4 172-4	t_5 172-5	t_6 172-6	t_7 172-7	t_8 172-8	t_9 172-9	t_{10} 172-10
t_4 162-4	t_4 170-4	t_4 174-4	t_4 162-4	t_5 176-5	t_6 176-6	t_7 176-7	t_8 176-8	t_9 176-9	t_{10} 176-10
t_5 162-5	t_5 170-5	t_5 174-5	t_5 178-5	t_5 162-5	t_6 180-6	t_7 180-7	t_8 180-8	t_9 180-9	t_{10} 180-10
t_6 162-6	t_6 170-6	t_6 174-6	t_6 178-6	t_6 182-6	t_6 162-6	t_7 184-7	t_8 184-8	t_9 184-9	t_{10} 184-10
t_7 162-7	t_7 170-7	t_7 174-7	t_7 178-7	t_7 182-7	t_7 188-7	t_7 162-7	t_8 188-8	t_9 188-9	t_{10} 188-10
t_8 162-8	t_8 170-8	t_8 174-8	t_8 178-8	t_8 182-8	t_8 188-8	t_8 190-8	t_8 162-8	t_9 192-9	t_{10} 192-10
t_9 162-9	t_9 170-9	t_9 174-9	t_9 178-9	t_9 182-9	t_9 188-9	t_9 190-9	t_9 194-9	t_9 162-9	t_{10} 196-10
t_{10} 162-10	t_{10} 170-10	t_{10} 174-10	t_{10} 178-10	t_{10} 182-10	t·0 188-10	t_{10} 190-10	t_{10} 194-10	t_{10} 198-10	t_{10} 162-10

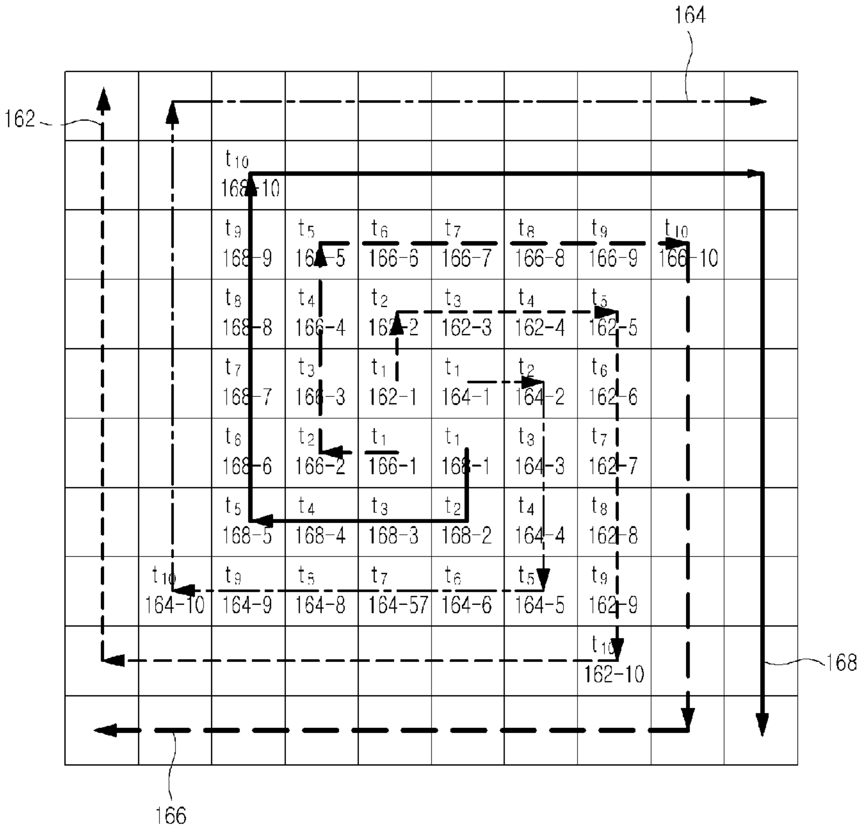
[Fig. 11]


162
164
t_6 t_7 t_8 t_9 t_{10}
162-6 162-7 162-8 162-9 162-10
t_1 t_2 t_3 t_4 t_5
162-1 162-2 162-3 162-4 162-5
t_6 t_7 t_8 t_9 t_{10}
164-6 164-7 164-8 164-9 164-10
t_2 t_3 t_4 t_5 t_6
166-2 166-3 166-4 166-5 166-6
t_7 t_8 t_9 t_{10}
168-7 168-8 168-9 168-10
t_7 t_8 t_9 t_{10}
166-7 166-8 166-9 166-10
166
168

[Fig. 12]


162
164
t_{10} t_9 t_8 t_7 t_6
162-10 162-9 162-8 162-7 162-6
t_7 t_8 t_9 t_{10}
164-7 164-8 164-9 164-10
t_5 t_4 t_3 t_2 t_1
162-5 162-4 162-3 162-2 162-1
t_2 t_3 t_4 t_5 t_6
164-2 164-3 164-4 164-5 164-6
t_6 t_5 t_4 t_3 t_2
166-6 166-5 166-4 166-3 166-2
t_3 t_4 t_5 t_6 t_7
166-3 166-4 166-5 166-6 166-7
t_{10} t_9 t_8 t_7
166-10 166-9 166-8 166-7
t_8 t_9 t_{10}
168-8 168-9 168-10
166
168

[Fig. 13]


164
162
t_{10} 168-10
t_9 168-9
t_5 166-5
t_6 166-6
t_7 166-7
t_8 166-8
t_9 166-9
t_{10} 166-10
t_8 168-8
t_4 166-4
t_2 162-2
t_3 162-3
t_4 162-4
t_5 162-5
t_7 168-7
t_3 166-3
t_1 162-1
t_1 164-1
t_2 164-2
t_6 162-6
t_6 168-6
t_2 166-2
t_1 166-1
t_1 168-1
t_3 164-3
t_7 162-7
t_5 168-5
t_4 168-4
t_3 168-3
t_2 168-2
t_4 164-4
t_8 162-8
t_{10} 164-10
t_9 164-9
t_5 164-8
t_7 164-57
t_6 164-6
t_5 164-5
t_9 162-9
t_{10} 162-10
168
166

MOVING PICTURE ENCODING/DECODING APPARATUS AND METHOD FOR PROCESSING OF MOVING PICTURE DIVIDED IN UNITS OF SLICES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation application of U.S. application Ser. No. 13/128,723 filed May 11, 2011, which claims priority from National Stage Application under 35 U.S.C. §371 of PCT/KR2009/006484 filed on Nov. 5, 2009, which claims priority from Korean Patent Application No. 10-2008-0111850 filed on Nov. 11, 2008 in the Korean Intellectual Property Office, all the disclosures of which are incorporated herein in their entireties by reference.

BACKGROUND

[0002] 1. Field

[0003] Apparatuses and methods consistent with exemplary embodiments relate to a moving picture encoding/decoding apparatus and method for processing of a moving picture, which is divided in units of slices.

[0004] 2. Description of the Related Art

[0005] In general, the amount of computation performed for motion estimation greatly affects the total amount of computation required for coding. For example, when motion estimation is performed with one or more forward/backward reference frames, as in the H.264/AVC compression encoding scheme, the complexity thereof is very high. Especially, in the case of an MPEG-4 AVC/H.264 compression video structure, when motion estimation with respect to a hierarchical B-picture is performed using various blocks in order to achieve temporal scalability, the complexity thereof increases exponentially.

[0006] Meanwhile, recently, with the development of multi-core technology, a greater number of moving picture encoding/decoding apparatuses based on parallel processing have been developed. According to a parallel processing method using H.264/AVC, which is a recent moving picture compression standard, an image is divided into regions, each of which is called a "slice," and each slice image region is individually encoded or decoded in each process or thread. Since the parallel processing method does not require information to be shared and transferred between image regions of slices, into which an image is divided, the parallel processing method has advantages in that the implementation thereof is easy and the efficiency of parallel processing is excellent.

[0007] FIG. **1** is a block diagram schematically illustrating the configuration of a conventional moving picture encoding apparatus for processing a moving picture divided in units of slices.

[0008] The moving picture encoding apparatus includes a memory **10**, a multi-core processor **20**, an MPEG data division module **30**, and a decoding/merging module **40**.

[0009] According to the conventional moving picture encoding apparatus, one-frame data of a bitstream encoded by an MPEG algorithm is stored in the memory **10**, is allocated as threads to cores within the multi-core processor **20**, is decoded, and is then merged.

[0010] The multi-core processor **20** includes a plurality of cores, i.e. central processing units (CPUs), which operate thread by thread, wherein each core operates independently. The memory **10** includes a plurality of buffers which store individual slices (e.g. slice **1**, slice **2**, . . . , slice N) received from the MPEG data division module **30**, and provide the stored slices to cores (core **1**, core **2**, . . . , core N) of the multi-core processor **20**.

[0011] The MPEG data division module **30**, when receiving MPEG data, extracts decoding information, divides the received MPEG data into slices, and distributes decoding processes for bitstreams based on the divided individual slice units to the cores in the multi-core processor as threads. To this end, the MPEG data division module **30** includes a header parser **32**, a slice divider **34**, a core computing load measurer **36**, and a distributor **38**.

[0012] The header parser **32** receives MPEG data in the form of a bitstream, and performs a basic header parsing operation, such as extraction of decoding information. In addition, the header parser **32** divides and allocates the region of the memory **10** so as to prepare the buffers for the slices. That is, the header parser **32** divides the region of the memory **10** into a plurality of buffers so as to correspond to the cores of the multi-core processor **20**, and allocates the buffers to the cores.

[0013] The slice divider **34** detects a slice start code within a bitstream and divides the bitstream in units of slices. The distributor **38** properly distributes bitstreams divided in units of slices to the buffers. The core computing load measurer **36** measures a computing occupancy of each core.

[0014] Meanwhile, referring to FIG. **1**, many moving picture codecs use a parallel processing scheme of dividing an image into slices and allocating the slices to cores, respectively, in order to support parallel processing in a multi-core environment. However, such a scheme degrades the encoding performance as a whole, as compared with a scheme of encoding the entire image.

[0015] Therefore, there is a necessity for a parallel processing-based moving picture encoding/decoding apparatus which can enhance the efficiency in encoding or decoding of a moving picture through an efficient slice division.

SUMMARY

[0016] One or more exemplary embodiments provide a moving picture encoding/decoding apparatus and method for processing of a moving picture, which is divided in units of slices.

[0017] In accordance with an aspect of an exemplary embodiment, there is provided a moving picture encoding apparatus for processing a moving picture which is divided in units of slices; the apparatus including: a slice divider which divides an input image into image slices in units of slices; an image encoder including a plurality of encoding units which receive and encode the image slices, respectively; a bitstream generator which generates a bitstream through use of the encoded image slices; and a synchronization controller which determines an encoding order of the image slices, and controlling the encoding units to encode the image slices in parallel according to the encoding order.

[0018] In accordance with another exemplary embodiment, there is provided a moving picture decoding apparatus for processing a moving picture which is divided in units of slices; the apparatus including: a slice divider which divides an input bitstream into bitstream slices in units of slices; an image decoder including a plurality of decoding units which receive and decode the bitstream slices, respectively; and a synchronization controller which determines a decoding order of the bitstream slices, and controlling the decoding units to decode the bitstream slices in parallel according to the decoding order.

[0019] In accordance with another aspect of an exemplary embodiment, there is provided an encoding method by a moving picture encoder which includes a plurality of encoding units for processing a moving picture divided in units of slices, the method including the steps of: dividing an input image into image slices in units of slices; determining an encoding order of a plurality of macroblocks included in the image slices into which the input image is divided; simultaneously encoding the respective image slices according to the encoding order through use of the encoding units; and generating a bitstream through use of the encoded image slices.

[0020] In accordance with another aspect of an exemplary embodiment, there is provided a decoding method by a moving picture decoder which includes a plurality of decoding units for processing a moving picture divided in units of slices, the method including: dividing an input bitstream into bitstream slices in units of slices; determining a decoding order of a plurality of macroblocks included in the bitstream slices into which the input bitstream is divided; and simultaneously decoding the respective bitstream slices according to the decoding order through use of the decoding units.

[0021] According to another aspect of an exemplary embodiment it is possible to increase the encoding efficiency through the sharing of partial information between image slices.

[0022] According to yet another aspect of an exemplary embodiment it is possible to process a moving picture divided in units of slices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The above and/or other aspects, features and advantages of the exemplary embodiments will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0024] FIG. **1** is a block diagram schematically illustrating the configuration of a conventional moving picture encoding apparatus for processing a moving picture divided in units of slices;

[0025] FIG. **2** is a block diagram schematically illustrating the configuration of a moving picture encoding apparatus for processing a moving picture divided in units of slices according to an exemplary embodiment;

[0026] FIG. **3** is a block diagram schematically illustrating the configuration of a moving picture decoding apparatus for processing a moving picture divided in units of slices according to an exemplary embodiment;

[0027] FIG. **4** is a flowchart illustrating a moving picture encoding method for processing a moving picture divided in units of slices according to an exemplary embodiment;

[0028] FIG. **5** is a flowchart illustrating a moving picture decoding method for processing a moving picture divided in units of slices according to an exemplary embodiment;

[0029] FIG. **6** is a view illustrating a moving picture encoding order in image slices according to an exemplary embodiment; and

[0030] FIGS. **7** to **13** are views illustrating moving picture encoding orders in image slices according to other exemplary embodiments.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0031] Hereinafter, exemplary embodiments will be described with reference to the accompanying drawings. In the following description, the same elements will be designated by the same reference numerals although they are shown in different drawings. In addition, in the following description of the exemplary embodiments, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the exemplary embodiments rather unclear.

[0032] FIG. **2** is a block diagram schematically illustrating the configuration of a moving picture encoding apparatus for processing a moving picture divided in units of slices according to an exemplary embodiment.

[0033] The moving picture encoding apparatus **50** includes a slice divider **60**, an image encoder **70**, a synchronization controller **90**, and a bitstream generator **80**.

[0034] The slice divider **60** divides an image, which is input to the moving picture encoding apparatus **50**, in units of slices, thereby generating image slices. In the following description, image slices represent images obtained by dividing an image in units of slices. The slice divider **60** can divide an input image into image slices and determine an encoding order for the image slices so that information can be shared between image slices.

[0035] In this case, sharing information between image slices signifies that, when the image encoder **70** encodes image slices, each image encoding unit makes reference to a pre-encoded image slice or an image slice, other than an image slice allocated to the image encoding unit itself, in order to encode the allocated image slice, wherein the image encoder **70** will be described later. For example, when a third image encoding unit **70-3** encodes a third image slice, the third image encoding unit **70-3** may make reference to a second image slice encoded in advance, or make reference to a first image slice encoded by a second image encoding unit **70-2**.

[0036] The image encoder **70** receives at least one image slice obtained by dividing an image in units of slices by the slice divider **60**, and encodes the received image slice. The image encoder **70** includes the first image encoding unit **70-1**, the second image encoding unit **70-2**, the third image encoding unit **70-3**, . . . , an Nth image encoding unit **70**-N, which receive and encode a first image slice, a second image slice, a third image slice, . . . , an Nth image slice, respectively.

[0037] As described above, when each image encoding unit encodes an image slice allocated to the image encoding unit itself, the image encoding unit may encode the allocated image slice by making an image slice, other than the allocated image slice. In this case, when making reference to another image slice, the image encoder **70** may make reference to information on each image slice in units of macroblocks included in each image slice.

[0038] For example, when the second image encoding unit **70-2** encodes a fifth image slice allocated to the second image encoding unit **70-2**, the second image encoding unit **70-2** may make reference to a fourth macroblock in a fourth image slice currently being encoded by the third image encoding unit. Information to which the image encoder **70** makes reference from an image slice or a macroblock included in an image slice includes, for example, motion estimation information according to each frame, a motion vector of each macroblock, and the number of coefficients, and such information may be stored in a memory (not shown) included in the moving picture encoding apparatus **50**. As described above, the image encoding units shares information between image slices with each other, thereby increasing the encoding efficiency.

[0039] The bitstream generator **80** receives each encoded image slice from the first image encoding unit **70-1** through the Nth image encoding unit **70**-N, and generates a bitstream.

[0040] When the image encoder **70** encodes image slices, the synchronization controller **90** synchronizes encoding time points of macroblocks included in the image slices. Each image slice includes at least one macroblock. The synchronization controller **90** according to an exemplary embodiment can simultaneously control the encoding time points of macroblocks included in image slices.

[0041] For example, it is assumed that a first image slice includes a first macroblock, a second macroblock, and a third macroblock, and a second image slice includes a fourth macroblock, a fifth macroblock, and a sixth macroblock. In addition, it is assumed that the first image slice is encoded by the first image encoding unit **70-1**, and the second image slice is encoded by the second image encoding unit **70-2**. The synchronization controller **90** according to an exemplary embodiment can control the first image encoding unit **70-1** and the second image encoding unit **70-2** such that the first macroblock of the first image slice and the fourth macroblock of the second image slice can be simultaneously encoded.

[0042] FIG. **3** is a block diagram schematically illustrating the configuration of a moving picture decoding apparatus for processing a moving picture divided in units of slices according to an exemplary embodiment.

[0043] According to an exemplary embodiment, the moving picture decoding apparatus **100** includes a bitstream parser **110**, the slice divider **60**, an image decoder **120**, an image generator **130**, and the synchronization controller **90**.

[0044] The bitstream parser **110** parses a bitstream input to the moving picture decoding apparatus **100**.

[0045] The slice divider **60** divides the bitstream, which has been parsed by the bitstream parser **110**, in units of slices, thereby generating bitstream slices. Hereinafter, each bitstream obtained by dividing a bitstream in units of slices will be referred to as a "bitstream slice." The slice divider **60** may determine a decoding order of bitstream slices obtained by dividing a bitstream in units of slices. The slice divider **60** transfers first to Nth bitstream slices to the image decoder **120** according to the decoding order.

[0046] The image decoder **120** decodes at least one bitstream slice which is input in the order determined by the slice divider **60**. The image decoder **120** includes a first image decoding unit **120-1**, a second image decoding unit **120-2**, . . . , an Nth image decoding unit **120**-N, which receive and decode a first bitstream slice, a second bitstream slice, . . . , an Nth bitstream slice, respectively.

[0047] The image generator **130** receives each decoded bitstream slice, and generates an image. In this case, the generated image may be an image divided into image slices by the moving picture encoding apparatus **50**, and may be output and/or reproduced through a display unit (not shown) provided in advance in the moving picture decoding apparatus **100** according to an exemplary embodiment.

[0048] When the image decoder **120** decodes bitstream slices, the synchronization controller **90** synchronizes decoding time points of macroblocks included in the bitstream slices. The synchronization controller **90** according to an exemplary embodiment can simultaneously control the decoding time points of macroblocks included in the bitstream slices.

[0049] For example, it is assumed that a first bitstream slice includes a first macroblock, a second macroblock, and a third macroblock, and a second bitstream slice includes a fourth macroblock, a fifth macroblock, and a sixth macroblock. In addition, it is assumed that the first bitstream slice is decoded by the first image decoding unit **120-1**, and the second bitstream slice is decoded by the second image decoding unit **120-2**. The synchronization controller **90** can control the first image decoding unit **120-1** and the second image decoding unit **120-2** such that the first macroblock of the first bitstream slice and the fourth macroblock of the second bitstream slice can be simultaneously decoded.

[0050] FIG. **4** is a flowchart illustrating a moving picture encoding method for processing a moving picture divided in units of slices according to an exemplary embodiment.

[0051] In step **140**, the slice divider **60** divides an image, which is input to the moving picture encoding apparatus **50**, into image slices based on a slice unit. In step **142**, the slice divider **60** allocates the image slices to the image encoder **70**, i.e. the image encoding units.

[0052] Thereafter, in step **144**, the moving picture encoding apparatus **50** encodes the image slices in parallel while controlling the encoding time point of each image slice. In this case, controlling the encoding time point of each image slice is performed by the synchronization controller **90**, and encoding the image slices in parallel is performed by the image encoder **70**.

[0053] When the image slices have been encoded, the bitstream generator **80** generates a bitstream through the use of the encoded image slices in step **146**. In step **148**, the moving picture encoding apparatus **50** outputs the generated bitstream.

[0054] FIG. **5** is a flowchart illustrating a moving picture decoding method for processing a moving picture divided in units of slices according to an exemplary embodiment.

[0055] In step **150**, the slice divider **60** divides a bitstream, which is input to the moving picture decoding apparatus **100**, into bitstream slices based on a slice unit. In step **152**, the slice divider **60** allocates the bitstream slices to the image decoder **120**, i.e. the image decoding units.

[0056] Thereafter, in step **154**, the moving picture decoding apparatus **100** decodes the bitstream slices in parallel while controlling the decoding time point of each bitstream slice. In this case, controlling the decoding time point of each bitstream slice is performed by the synchronization controller **90**, and decoding the bitstream slices in parallel is performed by the image decoder **120**.

[0057] When the bitstream slices have been decoded, the image generator **130** generates an image through the use of the decoded bitstream slices in step **156**. In step **158**, the moving picture decoding apparatus **100** outputs the generated image through a display unit (not shown) provided in advance.

[0058] Therefore, according to the exemplary embodiments described above, a moving picture divided in units of slices can be processed.

[0059] FIG. **6** is a view illustrating a moving picture encoding order in image slices according to an exemplary embodiment.

[0060] FIG. **6** shows one frame of a moving picture. Referring to FIG. **6**, one frame includes a first image slice **162**, a second image slice **164**, a third image slice **166**, a fourth image slice **168**, and a fifth image slice **170**. In addition, each of image slices **162**, **164**, **166**, **168**, and **170** includes 20 macroblocks.

[0061] It is assumed that a first image encoding unit **70-1** encodes the first image slice **162**, a second image encoding unit **70-2** encodes the second image slice **164**, a third image encoding unit **70-3** encodes the third image slice **166**, a fourth image encoding unit **70-4** encodes the fourth image slice **168**, and a fifth image encoding unit **70-5** encodes the fifth image slice **170**.

[0062] According to an exemplary embodiment, the first image encoding unit **70-1** encodes macroblocks included in the first image slice **162** in the order of "**162-1**(t_1)", "**162-2**(t_2)", "**162-3**(t_3)", "**162-4**(t_4)", "**162-5**(t_5)", "**162-6**(t_6)", "**162-7**(t_7)", "**162-8**(t_8)", . . . , "**162**-N(t_N)". Similarly, the second image encoding unit **70-2** encodes macroblocks included in the second image slice **164** in the order of "**164-5**(t_5)", "**164-6**(t_6)", "**164-7**(t_7)", "**164-8**(t_8)", "**164-9**(t_9)", "**164-10**(t_{10})", "**164-11**(t_{11})", "**164-12**(t_{12})", "**164-13**(t_{13})", . . . , "**164**-N(t_N)"; the third image encoding unit **70-3** encodes the third image slice **166** in the order of "**166-9**(t_9)", "**166-10**(t_{10})", "**166-11**(t_{11})", "**166-12**(t_{12})", "**166-13**(t_{13})", "**166-14**(t_{14})", "**166-15**(t_{15})", "**166-16**(t_{16})", . . . , "**166**-N(t_N)"; the fourth image encoding unit **70-4** encodes the fourth image slice **168** in the order of "**168-13**(t_{13})", "**168-14**(t_{14})", "**168-15**(t_{15})", "**168-16**(t_{16})", "**168-17**(t_{17})", "**168-18**(t_{18})", "**168-19**(t_{19})", "**168-20**(t_{20})", . . . , "**168**-N(t_N)"; and the fifth image encoding unit **70-5** encodes the fifth image slice **170** in the order of "**170-17**(t_{17})", "**170-18**(t_{18})", "**170-19**(t_{19})", "**170-20**(t_{20})", "**170-21**(t_{21})", "**170-22**(t_{22})", . . . , "**170**-N(t_N)". In the above description, each numeral expressed in parentheses represents an encoding time point of each corresponding macroblock. For example, macroblock **170-21** starts to be encoded at time point t_{21} by the fifth image encoding unit **70-5**.

[0063] Referring to FIG. **6**, the first image encoding unit **70-1** encodes macroblock **162-1**(t_1) first of all. Since macroblock **162-1**(t_1), which is a macroblock (hereinafter, referred to as an "adjacent macroblock") adjacent to macroblock **162-2**(t_2), has already been encoded, the first image encoding unit **70-1** can make reference to macroblock **162-1**(t_1) when encoding macroblock **162-2**(t_2). Similarly, the first image encoding unit **70-1** encodes macroblock **162-3**(t_3) by making reference to macroblocks **162-1**(t_1) and **162-2**(t_2). Also, when macroblock **162-3**(t_3) has been encoded, the first image encoding unit **70-1** encodes macroblock **162-4**(t_4) by making reference to macroblocks **162-1**(t_1), **162-2**(t_2), and **162-3**(t_3), which correspond to adjacent macroblocks of macroblock **162-4**(t_4). Also, in the same manner, the first image encoding unit **70-1** encodes macroblock **162-5**(t_5) by making reference to macroblocks **162-3**(t_3) and **162-4**(t_4). Here, the range of adjacent macroblocks may be determined in such a manner that, for example, referring to FIG. **6**, the adjacent macroblocks of macroblock **164-4** in the second image slice **164** correspond to macroblocks **162-1**, **162-2**, **162-3**, **164-3**, **164-5**, **166-5**, **166-6**, and **166-7**.

[0064] In addition, when adjacent macroblocks **162-2**(t_2) and **162-4**(t_4) of macroblock **164-5**(t_5) have been encoded, the second image encoding unit **70-2** can encode macroblock **164-5**(t_5). That is, a time point at which the first image encoding unit **70-1** encodes macroblock **162-5**(t_5) and a time point at which the second image encoding unit **70-2** encodes macroblock **164-5**(t_5) become equal t_o each other. In this case, the synchronization controller **90** controls the first image encoding unit **70-1** and the second image encoding unit **70-2** so that a time point at which the first image encoding unit **70-1** encodes macroblock **162-5**(t_5) can be equal to a time point at which the second image encoding unit **70-2** encodes macroblock **164-5**(t_5).

[0065] Similarly, when macroblocks **164-6**(t_6) and **164-8**(t_8) have been encoded, the third image encoding unit **70-3** can encode macroblock **166-9**(t_9). While the third image encoding unit **70-3** encodes macroblock **166-9**(t_9), the first image encoding unit **70-1** encodes macroblock **162-9**(t_9), and the second image encoding unit **70-2** encodes macroblock **164-9**(t_9).

[0066] As described above, the exemplary embodiments provide the moving picture encoding apparatus **50**, which can process image slices allocated to each image encoding unit in such a manner as to encode a plurality of image slices at the same time. The method for allocating image slices and encoding macroblocks, as described above, can be applied even to the moving picture decoding apparatus **100** according to the exemplary embodiment. In addition, an image slice division scheme, an encoding order of macroblocks, and an encoding scheme thereof, which will be described later with reference to FIG. **7**, can be applied to the moving picture decoding apparatus **100**, too.

[0067] For example, a time point at which the second image decoding unit **120-2** decodes macroblock **164-9**(t_9) and a time point at which the third image decoding unit **120-3** decodes macroblock **166-9**(t_9) are equal to each other.

[0068] FIGS. **7** to **12** are views illustrating moving picture encoding orders in image slices according to other exemplary embodiments.

[0069] FIG. **7** shows a frame including five image slices **162**, **164**, **166**, **168**, and **170**, as shown in FIG. **6**. Referring to FIG. **7**, the image encoder **70** encodes macroblocks, which are included in each image slice **162**, **164**, **166**, **168**, and **170**, in a Z-shape along a horizontal direction within each corresponding image slice.

[0070] In FIG. **7**, the first image encoding unit **70-1** encodes macroblock **162-11**(t_{11}) by making reference to macroblocks **162-9**(t_9) and **162-10**(t_{10}) at the same time as the second image encoding unit **70-2** encodes macroblock **164-11**(t_{11}) by making reference to pre-encoded macroblocks **162-7**(t_7), **162-8**(t_8), **164-9**(t_9), and **164-10**(t_{10}). Also, in this case, the third image encoding unit **70-3** encodes macroblock **166-11**(t_{11}) by making reference to pre-encoded macroblocks **164-7**(t_7), **164-8**(t_8), **166-9**(t_9), and **166-10**(t_{10}). In the same manner, the fourth image encoding unit **70-4** encodes macroblock **168-13**(t_{13}), which is included in the fourth image slice **168**, through the use of macroblocks **166-11**(t_{11}) and **166-12**(t_{12}) included in the third image slice **166**. In this case, it is assumed that one or more pre-encoded macroblocks have been stored in a memory (not shown) provided in advance in the moving picture encoding apparatus **50**.

[0071] FIG. **8** is a view illustrating a frame including 10 image slices. Each image slice shown in FIG. **8** includes 10 macroblocks, differently from the image slices shown in FIGS. **6** and **7**. According to the exemplary embodiment of FIG. **8**, a macroblock can be encoded by making reference to at least one adjacent macroblock when the adjacent macroblock has been encoded in advance, similar to the cases of FIGS. **6** and **7**.

[0072] For example, when macroblock **162-1** in a first image slice has been encoded, the first image encoding unit **70-1** can encode macroblock **162-2**, which is an adjacent macroblock of macroblock **162-1**. Also, when macroblocks **162-1** and **162-2** have been encoded, the first image encoding unit **70-1** can encode macroblock **162-3**.

[0073] Referring to FIG. **8**, when macroblocks **162-1** and **162-2** have been encoded, the synchronization controller **90** synchronizes the first image encoding unit **70-1** and the second image encoding unit **70-2** to encode macroblocks **162-3** and **164-3** at the same time. Also, when macroblocks **162-4** and **164-4** have been encoded by the first image encoding unit **70-1** and second image encoding unit **70-2**, the synchronization controller **90** synchronizes the first image encoding unit **70-1**, the second image encoding unit **70-2**, and the third image encoding unit **70-3** to encode macroblocks **162-5**, **164-5**, and **166-5** at the same time.

[0074] The synchronization controller **90** controls a time point at which each image encoding unit encodes each macroblock in such a manner as described above, thereby controlling the image encoder **70**, which includes a plurality of cores (not shown) and buffers (not shown), to efficiently encode an image divided in units of slices.

[0075] FIGS. **9** to **12** show cases where a frame having 10×10 macroblocks in the horizontal and vertical directions is divided into image slices in various manners. Referring to FIGS. **9** to **12**, it can be understood that the encoding order of macroblocks included in image slices may vary depending on image division schemes.

[0076] Referring to FIG. **9**, ten macroblocks in the vertical direction among 10×10 macroblocks correspond to a first image slice **162**; nine macroblocks in the horizontal direction among the remaining macroblocks, except for the first image slice **162**, correspond to a second image slice **164**; and nine macroblocks in the vertical direction among the remaining macroblocks, except for the first image slice **162** and the second image slice **164**, correspond to a third image slice **166**. That is, one frame of an image input to the moving picture encoding apparatus **50** is divided in units of slices in alternating the vertical and horizontal directions.

[0077] Also, referring to FIG. **9**, each image slice is encoded in such a manner that, after macroblock **162-1**(t_1) in the first image slice **162** has been encoded, macroblocks **162-2**(t_2) and **164-2**(t_2) are simultaneously encoded, macroblocks **162-3**(t_3), **164-3**(t_3), and **166-3**(t_3) are simultaneously encoded, and then macroblocks **162-4**(t_4), **164-4**(t_4), **166-4** (t_4), and **168-4**(t_4) are simultaneously encoded.

[0078] In the case of a frame shown in FIG. **10**, after macroblock **162-1**(t_1) in a first image slice **162** is encoded first, macroblock **162-2**(t_2) in the first image slice **162**, macroblock **164-2**(t_2) in a second image slice **164**, and macroblock **166-2**(t_2) in a third image slice **166** are encoded. Thereafter, the synchronization controller **90** according to an exemplary embodiment controls the image encoder **70** to encode macroblock **162-3**(t_3) in the first image slice **162**, macroblock **164-3**(t_3) in the second image slice **164**, macroblock **166-3** (t_3) in the third image slice **166**, and macroblock **168-3**(t_3) in a fourth image slice **168**. The image encoder **70** encodes a plurality of image slices, which are included in a frame, in parallel in the aforementioned manner under the control of the synchronization controller **90**.

[0079] FIGS. **11** and **12** illustrate encoding orders of image slices when one frame includes four image slices **162**, **164**, **166**, and **168**.

[0080] Referring to FIG. **11**, first, macroblocks **162-1**(t_1), **162-2**(t_2), **162-3**(t_3), **162-4**(t_4), and **162-5**(t_5) in a first image slice **162** are encoded in regular sequence, and macroblocks **166-2**(t_2), **166-3**(t_3), **166-4**(t_4), **166-5**(t_5), and **166-6**(t_6) in a third image slice **166** are encoded in regular sequence. When macroblock **162-5**(t_5) in the first image slice **162** and macroblock **166-5**(t_5) in the third image slice **166** have been encoded, the second image encoding unit **70-2** can encode macroblock **164-6**(t_6) in a second image slice **164** by making reference to macroblock **162-5**(t_5). Also, when macroblock **164-6**(t_6) in the second image slice **164** has been encoded, the fourth image encoding unit **70-4** can encode macroblock **168-7**(t_7) in a fourth image slice by making reference to macroblock **162-5**(t_5), macroblock **164-6**(t_6), and macroblock **166-6**(t_6) in the third image slice **166**, wherein macroblock **166-6**(t_6) is encoded at the same time as macroblock **164-6**(t_6).

[0081] Referring to FIG. **12**, it can be understood that macroblock **162-1** of a first image slice **162** is positioned in the center of a frame. Accordingly, when macroblock **162-1**(t_1) is encoded by the first image encoding unit **70-1**, it is possible to encode macroblock **164-2** of a second image slice and macroblock **166-2** of a third image slice, which correspond to adjacent macroblocks of macroblock **162-1**. The moving picture encoding apparatus **50** according to an exemplary embodiment progresses the encoding in a direction from the center of the frame to the edge of the frame.

[0082] FIG. **13** is a view illustrating a case where the moving picture encoding apparatus **50** performs the encoding of macroblocks in a sequence progressing in the form of a spiral.

[0083] According to another exemplary embodiment shown in FIG. **13**, a frame includes a first image slice **162**, a second image slice **164**, a third image slice **166**, and a fourth image slice **168**, wherein each image slice has the form of a spiral. According to the exemplary embodiment shown in FIG. **13**, encoding is performed in such a manner that macroblocks **162-1**(t_1), **164-1**(t_1), **166-1**(t_1), and **168-1**(t_1) are encoded at the same time; macroblocks **162-2**(t_2), **164-2**(t_2), **166-2**(t_2), and **168-2**(t_2) are encoded at the same time; and then macroblocks **162-3**(t_3), **164-3**(t_3), **166-3**(t_3), and **168-3** (t_3) are encoded at the same time.

[0084] The image slice division methods as described above are just exemplary embodiments, and various modifications, additions and substitutions are possible to increase the encoding efficiency through the sharing of partial information between image slices. Therefore, the aspects of the exemplary embodiments are not limited to the aforementioned exemplary embodiments and accompanying drawings. In addition, it will be understood by those skilled in the art that, when macroblocks are encoded, the subjects of pre-encoded adjacent macroblocks may change in form and detail depending on image slice division schemes.

What is claimed is:

1. A decoding apparatus, the apparatus comprising:

a controller configured to obtain information related to a block from a bitstream, to divide a frame into a plurality of blocks based on the information related to the block, the plurality of blocks comprising at least two rows, and to obtain decoding information by decoding a second block in a first row; and

a decoder configured to decode a third block in the first row and a first block in a second row using the decoding information.

2. The apparatus of claim **1**, wherein the third block in the first row and the first block in the second row are decoded in parallel.

3. The apparatus of claim **1**, wherein the information related to the block includes split information.

* * * * *